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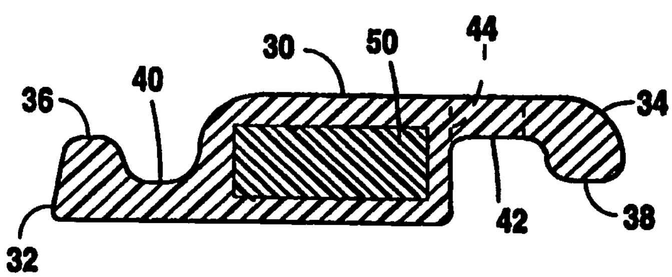
(54) Title: SUPPORT CORE RIBBON FOR COLD-SHRINK TUBE

(57) Abstract

A core for an elastomeric tubing assembly is produced from a ribbon (30) helically wound on itself to form a cylindrical tube. The edges (32, 34) of the ribbon (30) are formed to interlock with each other and are contoured to facilitate ultrasonic welding of the edges (32, 34). A support member (50) is coextruded in the ribbon (30) to provide increased resistance to premature collapse of the tube.



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Support Core Ribbon For Cold-Shrink Tube

Field of the Invention

This application is a continuation-in-part application of U.S. Application 08/384,516, filed on February 6, 1995, now issued United States Patent No. 5,670,223. This invention relates generally to elastomeric sleeving supported by a removable core, and particularly to construction of the core.

Background of the Invention

United States patent number 3,515,798, assigned to the assignee of the present invention, describes an elastomeric cover and removable core assembly which is particularly useful in the electrical distribution industry. However, the application of rubbery insulating sleeves to electric wire or cable splice areas is illustrative, and although the invention will be described primarily in terms of devices and procedures adapted particularly therefor, it is not to be construed as limited thereto, being equally applicable, for example, in the application of corrosion-preventing protective sleeves to welded pipe joints. The assembly is typically referred to as cold shrink tubing to differentiate it from polymeric tubing which may be shrunk by the application of heat.

Figure 1 illustrates a typical use for and construction of a cold-shrink tube assembly and shows two cable-ends 11 comprising a stranded conductor 12 and an insulating covering 13. The covering is cut away at 14 and the conductors 12 joined together in end-to-end configuration by suitable means which may

typically consist of a compressed or indented metal sleeve or a close-fitting metal tube with set-screw retainers. The joint or splice may be covered with insulating mastic or tape, here omitted for clarity of illustration.

The cold-shrink tube assembly is slipped over one of the wire-ends prior to joining the two ends. After the splice is completed, the assembly is slid into position over the splice area and the support is removed to permit the elastic cover to contract and form a tight fit. The process will be apparent from the illustration. The support comprises a unitary tubular core 15 helically grooved along its entire length, the continuous groove 16 permitting the core 15 to be pulled out into a continuous strip 17 which is removed through the bore, i.e., from between the core 15 and the cable 11. An elastic tube 18 in radially extended or stretched condition is supported on the core 15. As the strip 17 is progressively withdrawn, the tube 18 contracts about the cable as at 19 to form a closely conforming and tightly retained protective covering. Contraction of the tube results in the application of a resultant force against the end of the core 15 and assists in the removal of the strip 17 as the core 15 is unwound.

Although the construction described above has been used effectively for many years, considerable effort has been invested to reduce the amount of material used for the core 15 without compromising the strength of the core 15, i. e., its ability to withstand the compressive forces imposed upon it by the elasticity of the tube 18.

One method of reducing the amount of material used in the core 15 has been to produce the core 15 from a continuous ribbon 20 such as that shown in Figures 2 and 3. The ribbon 20 includes edges 22 and 24 which interlock, as shown in Figure 3, when the ribbon 20 is helically wound to form a tubular core. The interlocked edges 22 and 24 may be joined by such means as adhesives, heat welding or solvent welding, but the preferred method is ultrasonic welding. The construction of Figures 2 and 3 was effective to reduce the amount of material used in the core 15 since the thickness of the core tube could be reduced as it was no longer necessary to cut a groove 16 in the material to form the helical line of weakening which allowed the core 15 to be pulled as a strip 17 from the assembly. The joint between the edges 22 and 24 of the joined ribbon 20 formed the helical line of weakness around the core 15. Unfortunately, it was found that the extensive surface area of the contact between the two edges 22 and 24 of the ribbon 20 resulted in bonds at the joint surface which were difficult to control, both in terms of location and strength. As a result, the core 15 was at times too weak to support the elastomeric sleeve 18 or too strong to allow easy stripping of the core 15 from the sleeve 18.

The present invention modifies the shape of the ribbon edges 22 and 24 in order to achieve greater uniformity of bonding at the joint.

As less material is used in the support core, the possibility of premature collapse increases, especially as the diameter of the core becomes larger. The support core must have strength sufficient to resist

collapsing under the compressive force of the tube for long periods of time and at elevated temperatures. The external pressure of the tube can cause collapsing of the support core, for instance, by buckling. This effect can be enhanced by the uneven thickness of the expanded tube which results in uneven pressure on the support core. Subject to this uneven pressure, the support core takes on an oval shape which is easier to collapse than a perfect circular cylinder. Ellipicity is the most important defect which determines premature collapse of circular supporting tubular cores. As the diameter of the support cores and expanded elastic tubings increases, the defects may become more pronounced and thus make premature collapse more common. Further, for given materials, the thickness of support cores required to support large diameter expanded elastic tubings is a fast function of the diameter of the core. Hence, there has been a natural limit to the size of tubings which can be reliably supported by collapsible support cores without the wall thickness of the core becoming unacceptably large.

The invention provides a ribbon with greater hoop strength by placing within the ribbon a support member formed of a material capable of withstanding high temperatures and increased pressure associated with large diameter support cores and stretched elastic tubings.

Summary of the Invention

The present invention produces cold-shrink tube assembly cores having more uniform and predictable characteristics than previous core constructions. The

core is manufactured from a ribbon adapted to be edge joined to itself to form a helically wound tube. The ribbon comprises a longitudinal body having first and second major surfaces and first and second edges. A support member extends longitudinally through the body of the ribbon. The ribbon additionally comprises a first coupling projection extending from the first major surface toward the second major surface and terminating short of the second major surface, a second coupling projection extending from the second major surface toward the first major surface and terminating short of the first major surface, recesses in the ribbon adjacent the first and the second coupling projections for accepting the projections and thus permitting the first coupling projection of one ribbon section to engage the second coupling projection of another ribbon section with the major surfaces of the ribbon sections aligned to form a smooth surface of the tube, the coupling projections being formed such that the first and the second coupling projections may engage each other along a continuous surface free of any surfaces which are perpendicular to said major surfaces.

The support member within the body of the ribbon may be a coextruded polymer, such as ABS resin or modified PPO resin. The support member gives additional hoop strength to the ribbon such that the core is more resistant to premature collapse when subjected to high pressures associated with large diameter stretched elastic tubes, or when stored in high temperature conditions.

The ribbon may further include perforations within the larger recess to alternatively or additionally increase the uniformity of the force necessary to separate the helical coils of the core when it is desired to remove the core from the sleeve.

Brief Description of the Drawings

The present invention will be more particularly described with respect to the following drawings, wherein like numbers refer to like parts in the several views, and wherein:

Figure 1 is plan view, with portions in cross-section, of a cable and protective sleeve assembly of the prior art;

Figure 2 is a cross-sectional view of a ribbon used to manufacture a tubular core according to the prior art;

Figure 3 is a cross-sectional view of the ribbon of Figure 2 wound in helical fashion and edge-joined to manufacture a tubular core according to the prior art;

Figure 4 is a cross-sectional view of a ribbon used to manufacture a tubular core according to the present invention;

Figure 5 is a cross-sectional view of the ribbon of Figure 4 wound in helical fashion and edge-joined to manufacture a tubular core according to the present invention.

Figure 6 is a cross-sectional view of the ribbon of Figure 4 showing a support member within the body of the ribbon.

Description of the Preferred Embodiment

Figures 2 and 3 illustrate a ribbon 20 of the prior art from which a tubular core similar to the core 15 of Figure 1 may be wound. The ribbon 20 includes formed edges 22 and 24 which allow one edge 22 of one longitudinal portion of the ribbon 20 to interlock with the opposite edge 24 of another longitudinal portion of the ribbon 20 so that the ribbon 20 may be helically wound to form a cylindrical tube. This tube may be used as a core to support an elastomeric sleeve of rubber or other suitable material as shown in Figure 1.

As the ribbon 20 is helically wound, the edges are joined by a suitable method, such as by means of an adhesive, heat welding or solvent welding, but preferably ultrasonic welding, to provide sufficient strength in the finished core to support the sleeve in an expanded state. At the same time, it is desirable that the strength of the joint be sufficiently weaker than the strength of the ribbon 20 material so that the joint will separate predictably when it is desired to tear the core into a strip to effect its removal from the sleeve.

It has been found that the configuration of the edges 22 and 24 of the ribbon 20, and the resulting length of the line of contact between the mated edges, did not always allow the results of welding or bonding to be accurately predicted, either in the location of the weld along the line of contact between the halves or in the strength of the bond. In particular, it was found that the vertical surfaces associated with the construction of Figures 2 and 3 caused undesirable and unpredictable welding or bonding at these locations. This at times resulted in tearing of the material of

the ribbon 20 rather than separation at the joint, insufficient strength to support the elastomeric sleeve or undesirably high effort necessary to separate the core into a strip for removal.

Figures 4 and 5 illustrate a ribbon 30 designed to minimize the uncertainties associated with the ribbon 20 of Figures 2 and 3. The ribbon 30 is of any polymeric material suitable for ultrasonic welding or other bonding techniques and possessing sufficient strength to support the sleeve. Suitable materials have been found to be polyolefins. The ribbon 30 includes asymmetrical edges 32 and 34 which are designed to provide greater control over bonding in general, and, in particular, ultrasonic welding of the ribbon edges 32 and 34 to each other. Each edge 32 and 34 includes a coupling projection 36 and 38 extending from a major surface of the ribbon 30 to a point short of the opposite major surface of the ribbon 30. Each coupling projection 36 and 38 includes a contour which results in surface contact around substantially the entirety of the projection 38 without any vertical mating surface between the projection 38 and the projection 36.

Each coupling projection 36 and 38 is received by a recess 40 and 42 which are shaped to control contact between the mated edges of the ribbon 30. At least one of the recesses 42 is preferably oversized in relation to its respective coupling projection 36 so that an open area is produced adjacent the coupling projection 36 when the coupling projection 36 is inserted in the recess 42. In this manner, the extent of contact between the coupling projections 36 and 38 and the

recesses 40 and 42 is controlled, thus allowing further control over the bonding process used to join the ribbon edges 32 and 34.

As shown in Figures 4 and 5, the ribbon 30 may be formed with a continuous perforation 44 extending from the bottom of the larger recess 42 through the ribbon 30 to exit at the major surface of the ribbon 30. This perforation 44 may be used to control the force necessary to separate the core into a strip for removal. For example, the weld between the edges 32 and 34 of the ribbon 30 can be increased to a high strength level by appropriate selection of edge 32 and 34 contours, but the stripping force can be maintained at lower predetermined levels by proper selection of perforation size and the separation between adjacent perforations.

As shown in Figure 6, the body of ribbon 30 may be provided with a support member 50. Support member 50 extends longitudinally along the length of ribbon 30. Support member 50 preferably has greater strength and temperature resistance than the material forming the remainder of ribbon 30, such that the inclusion of support member 50 in ribbon 30 causes a support core formed from ribbon 30 to exhibit increased resistance to premature collapse when subjected to high pressures from large diameter stretched elastic tubes and when stored in high temperature conditions. Support member 50 is preferably a thermoplastic material, such as ABS resin (a terpolymer based on acrylonitrile, butadiene and styrene), while the remainder of ribbon 30 is formed of a thermoplastic material such as a polyolefin resin. Other suitable materials for support member 50

include, for example, a modified PPO (polyphenylene oxide)resin. Support member 50 is preferably coextruded with the body of ribbon 30. However, other methods of forming ribbon 30 with support member 50 as shown in Figure 6 may be recognized by those skilled in the art, and are contemplated to be within the scope of the present invention.

The improved strength of a core formed from a ribbon 30 as depicted in Figure 6 can be seen from the data in Table 1. The data in Table 1 was generated by forming cores from three types of ribbon: 1) polyolefin with no support member (POLY); 2) polyolefin coextruded with an ABS resin support member (CO-ABS); and 3) polyolefin coextruded with a modified PPO resin support member (CO-PPO). The core internal diameter was measured and the core was placed on its side in a test fixture in a 70C oven. The sample was left in the oven for 10 minutes. Ten minutes into the test, weight was placed on top of the sample and the core inner diameter measured. Additional weight was added and the inside diameter measured at ten minute intervals until the core had collapsed to an oval shape having an inside diameter 2/3 of the original diameter, at which point core failure was deemed to have occurred. All core samples had a wall thickness of 0.1 inch.

TABLE 1.

Core Material	Initial I.D. (mm)	Failure time (min)	Failure weight (lbs.)
POLY	46	30	5.39
POLY	68	40	8.08
CO-ABS	47	70	16.16
CO-ABS	61	40	8.08
CO-ABS	68	80	18.85
CO-ABS	68	60	13.47
CO-PPO	61	50	10.77
CO-PPO	69	50	10.77

As seen in Table 1, when comparing cores of similar initial diameters, those cores formed from a ribbon having a coextruded support member of either ABS or modified PPO performed significantly better than the cores formed from a ribbon lacking a support member. In particular, the cores having the support member took longer to fail and failed at higher weights than the cores without a support member.

Although the present invention has been described with respect to only a single embodiment of coupling projections, many modifications will be apparent to those skilled in the art. For example, both recesses 40 and 42 may be oversized with respect to the coupling projection 36 or 38 which is to be inserted therein. Also, although only a single projection and recess is shown at each edge of the ribbon, it is possible to have more than one projection on one or both edges, with recesses separating each projection. In this manner, any number of "fingers" could lock the edges of the ribbon together. Similarly, although support member 50 is shown as rectangular in shape, other

shapes and configurations of support member 50 would work equally well.

What is claimed is:

1. A ribbon adapted to be joined to itself to form a helically-wound tube, the ribbon comprising:

a longitudinal body having first and second major surfaces and first and second edges;

a support member extending longitudinally through the body;

a first coupling projection extending from said first major surface toward said second major surface and terminating short of said second major surface;

a second coupling projection extending from said second major surface toward said first major surface and terminating short of said first major surface;

recesses in said ribbon adjacent said first and said second coupling projections for accepting said projections and thus permit said first coupling projection of one ribbon section to engage said second coupling projection of another ribbon section with the major surfaces of said ribbon sections aligned to form a smooth surface on said tube;

said coupling projections being formed such that said first and said second coupling projections engage each other along a continuous surface free of any surfaces which are perpendicular to said major surfaces, at least one of said recesses being larger than the coupling projection to be inserted therein so that an open area is provided adjacent said coupling projection when said coupling projection is inserted within said one recess.

2. The ribbon of claim 1, wherein the body and support member are formed of thermoplastic materials.

3. The ribbon of claim 2, wherein the body and support member are coextruded.

4. The ribbon of claim 3, wherein the body is formed of a polyolefin resin and the support member is formed of ABS resin.

5. A ribbon according to claim 1 further including spaced perforations extending through said ribbon at said one recess.

6. An elastic sleeve assembly comprising an elastic sleeve member supported in highly stretched condition on a hollow core formed of a ribbon adapted to be joined to itself to form a helically-wound tube, the ribbon comprising:

a longitudinal body having first and second major surfaces and first and second edges;

a support member extending longitudinally through the body;

a first coupling projection extending from said first major surface toward said second major surface and terminating short of said second major surface;

a second coupling projection extending from said second major surface toward said first major surface and terminating short of said first major surface;

recesses in said ribbon adjacent said first and said second coupling projections for accepting said projections and thus permit said first coupling projection of one ribbon section to engage said second coupling projection of another ribbon section with the

major surfaces of said ribbon sections aligned to form a smooth surface on said tube;

said coupling projections being formed such that said first and said second coupling projections may engage each other along a substantially continuous surface free of any surface perpendicular to said major surfaces, at least one of said recesses being larger than the coupling projection to be inserted therein so that an open area is provided adjacent said coupling projection when said coupling projection is inserted within said one recess.

7. The ribbon of claim 6, wherein the body and support member are formed of thermoplastic materials.

8. The ribbon of claim 7, wherein the body and support member are coextruded.

9. The ribbon of claim 8, wherein the body is formed of a polyolefin resin and the support member is formed of ABS resin.

10. A ribbon according to claim 6 further including spaced perforations extending through said ribbon at said one recess.

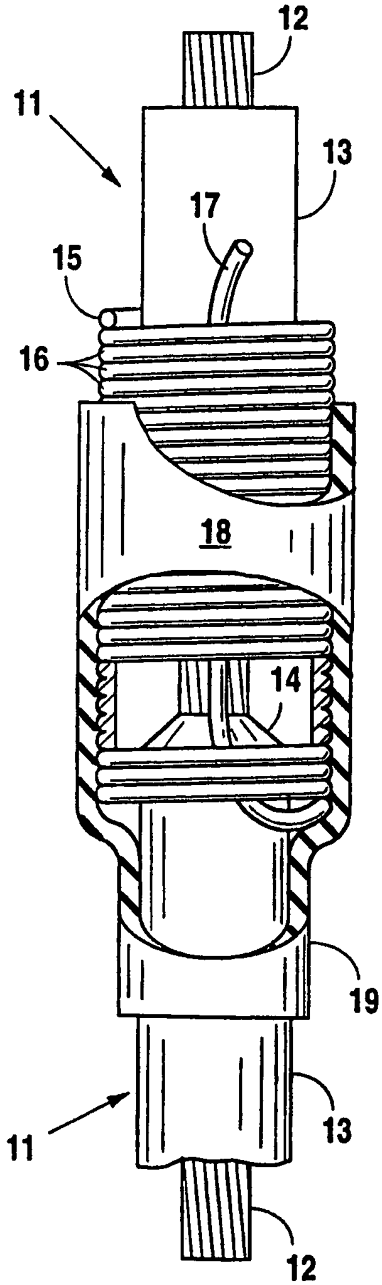

Fig. 1
(PRIOR ART)

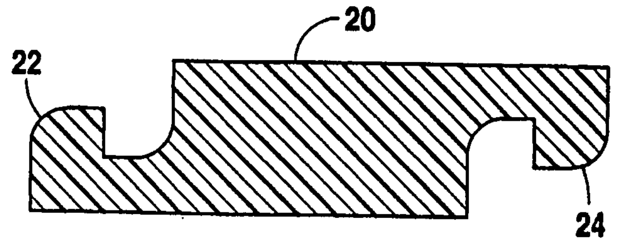

Fig. 2
(PRIOR ART)

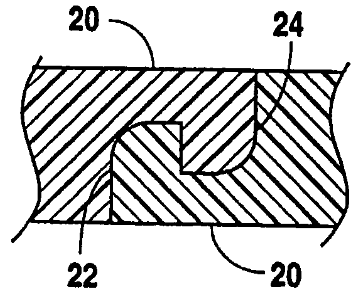

Fig. 3
(PRIOR ART)

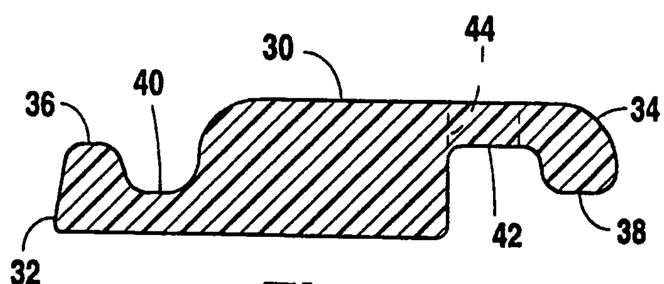

Fig. 4

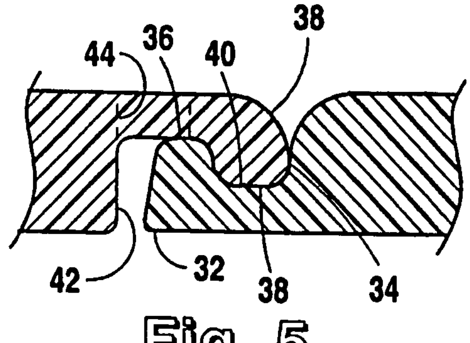

Fig. 5

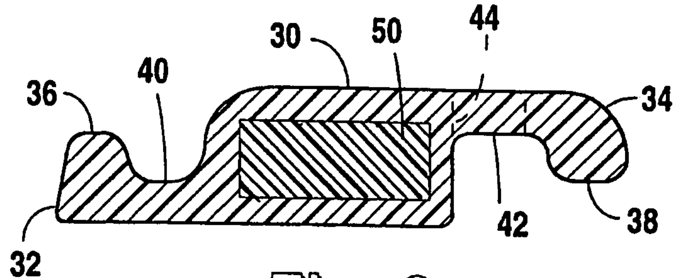

Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02G15/18 H02G1/14 B29C61/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02G B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 24977 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 15 August 1996 see page 6, line 33 - page 7, line 14; figures 4,5 ---	1,5,6,10
Y	EP 0 735 639 A (PIRELLI CAVI) 2 October 1996 see claim 1; figure 1 ---	1,5,6,10
A	EP 0 619 636 A (SOCIETE INDUSTRIELLE DE LIAISONS ELECTRIQUES) 12 October 1994 see column 4, line 22 - line 30; figure 2 ---	1,6
A	WO 83 00779 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 3 March 1983 see abstract; figures 1,2 ---	1,6
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 808 352 A (JOHNSON) 30 April 1974 see page 3, line 40 - line 46 see column 4, line 48 - line 55; figures 1,2 -----	1,6

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

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